

REPORT DOCUMENTATION PAGE**Form Approved**
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Service, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY) 13-04-2010		2. REPORT TYPE Master of Military Studies Research Paper		3. DATES COVERED (From - To) September 2009 - April 2010	
4. TITLE AND SUBTITLE LITTORAL COMBAT SHIP: IS IT A BLUE-GREEN ASSET?				5a. CONTRACT NUMBER N/A	
				5b. GRANT NUMBER N/A	
				5c. PROGRAM ELEMENT NUMBER N/A	
6. AUTHOR(S) Halbritter, Fiona C.				5d. PROJECT NUMBER N/A	
				5e. TASK NUMBER N/A	
				5f. WORK UNIT NUMBER N/A	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) USMC Command and Staff College Marine Corps University 2076 South Street Quantico, VA 22134-5068				8. PERFORMING ORGANIZATION REPORT NUMBER N/A	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A				10. SPONSOR/MONITOR'S ACRONYM(S) N/A	
				11. SPONSORING/MONITORING AGENCY REPORT NUMBER N/A	
12. DISTRIBUTION AVAILABILITY STATEMENT Unlimited					
13. SUPPLEMENTARY NOTES N/A					
14. ABSTRACT The Littoral Combat Ship was designed to meet Navy mission capabilities. The LCS will support USMC missions by providing littoral security. The LCS is an ideal platform for a naval fire support mission package. This capability would directly support USMC warfighting functions and future missions including distributed operations.					
15. SUBJECT TERMS Littoral Combat Ship					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON Marine Corps University / Command and Staff College
a. REPORT Unclass	b. ABSTRACT Unclass	c. THIS PAGE Unclass			19b. TELEPHONE NUMBER (include area code) (703) 784-3330 (Admin Office)

INSTRUCTIONS FOR COMPLETING SF 298

1. REPORT DATE. Full publication date, including day, month, if available. Must cite at least the year and be Year 2000 compliant, e.g., 30-06-1998; xx-08-1998; xx-xx-1998.

2. REPORT TYPE. State the type of report, such as final, technical, interim, memorandum, master's thesis, progress, quarterly, research, special, group study, etc.

3. DATES COVERED. Indicate the time during which the work was performed and the report was written, e.g., Jun 1997 - Jun 1998; 1-10 Jun 1996; May - Nov 1998; Nov 1998.

4. TITLE. Enter title and subtitle with volume number and part number, if applicable. On classified documents, enter the title classification in parentheses.

5a. CONTRACT NUMBER. Enter all contract numbers as they appear in the report, e.g. F33615-86-C-5169.

5b. GRANT NUMBER. Enter all grant numbers as they appear in the report, e.g. 1F665702D1257.

5c. PROGRAM ELEMENT NUMBER. Enter all program element numbers as they appear in the report, e.g. AFOSR-82-1234.

5d. PROJECT NUMBER. Enter all project numbers as they appear in the report, e.g. 1F665702D1257; ILIR.

5e. TASK NUMBER. Enter all task numbers as they appear in the report, e.g. 05; RF0330201; T4112.

5f. WORK UNIT NUMBER. Enter all work unit numbers as they appear in the report, e.g. 001; AFAPL30480105.

6. AUTHOR(S). Enter name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. The form of entry is the last name, first name, middle initial, and additional qualifiers separated by commas, e.g. Smith, Richard, Jr.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES). Self-explanatory.

8. PERFORMING ORGANIZATION REPORT NUMBER. Enter all unique alphanumeric report numbers assigned by the performing organization, e.g. BRL-1234; AFWL-TR-85-4017-Vol-21-PT-2.

9. SPONSORING/MONITORS AGENCY NAME(S) AND ADDRESS(ES). Enter the name and address of the organization(s) financially responsible for and monitoring the work.

10. SPONSOR/MONITOR'S ACRONYM(S). Enter, if available, e.g. BRL, ARDEC, NADC.

11. SPONSOR/MONITOR'S REPORT NUMBER(S). Enter report number as assigned by the sponsoring/ monitoring agency, if available, e.g. BRL-TR-829; -215.

12. DISTRIBUTION/AVAILABILITY STATEMENT. Use agency-mandated availability statements to indicate the public availability or distribution limitations of the report. If additional limitations/restrictions or special markings are indicated, follow agency authorization procedures, e.g. RD/FRD, PROPIN, ITAR, etc. Include copyright information.

13. SUPPLEMENTARY NOTES. Enter information not included elsewhere such as: prepared in cooperation with; translation of; report supersedes; old edition number, etc.

14. ABSTRACT. A brief (approximately 200 words) factual summary of the most significant information.

15. SUBJECT TERMS. Key words or phrases identifying major concepts in the report.

16. SECURITY CLASSIFICATION. Enter security classification in accordance with security classification regulations, e.g. U, C, S, etc. If this form contains classified information, stamp classification level on the top and bottom of this page.

17. LIMITATION OF ABSTRACT. This block must be completed to assign a distribution limitation to the abstract. Enter UU (Unclassified Unlimited) or SAR (Same as Report). An entry in this block is necessary if the abstract is to be limited.

United States Marine Corps
Command and Staff College
Marine Corps University
2076 South Street
Marine Corps Combat Development Command
Quantico, Virginia 22134-5068

MASTER OF MILITARY STUDIES

TITLE:

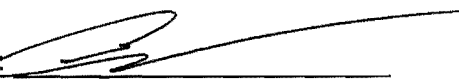
LITTORAL COMBAT SHIP: IS IT A BLUE-GREEN ASSET?


SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF MASTER OF MILITARY STUDIES

AUTHOR: LCDR Fiona C Halbritter, USN


ACADEMIC YEAR 2009-2010

Mentor: Dr. Adam Cobb

Approved: 

Approved: 

Date: 4/2/2010

JW Gordon

4/2/2010

DISCLAIMER

THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

QUOTATION FROM ABSTRACTION FROM, OR REPRODUCTION OF ALL OR ANY PART OF THIS DOCUMENT IS PERMITTED PROVIDED PROPER ACKNOWLEDGEMENT IS MADE.

TABLE OF CONTENTS

	Page
DISCLAIMER.....	ii
LIST OF ILLUSTRATIONS.....	iv
EXECUTIVE SUMMARY.....	v
INTRODUCTION.....	1
THE LITTORAL COMBAT SHIP CONCEPT.....	1
LCS DESIGN.....	3
MODULARITY.....	6
LCS PROS AND CONS.....	7
CURRENT MISSION PACKAGES.....	9
ASW.....	10
MCM.....	10
SUW.....	11
POSSIBLE MISSION PACKAGES.....	12
FUTURE NAVAL MISSION PACKAGE.....	13
SEA BASING / LOGISTICAL SUPPORT.....	14
FIRE SUPPORT.....	16
LCS SUPPORT TO DISTRIBUTED OPERATIONS.....	17
CONCLUSION.....	18
ENDNOTES.....	20
APPENDIX A.....	25
BIBLIOGRAPHY.....	30

ILLUSTRATIONS

	Page
Figure 1. Lockheed Martin LCS design concept	25
Figure 2. LCS 1 <i>Freedom</i>	25
Figure 3. Image of General Dynamics LCS design concept.....	26
Figure 4. General Dynamics LCS interior design concept.....	26
Figure 5. LCS 2 <i>Independence</i>	27
Figure 6. ASW Mission Package Components.....	27
Figure 7. ASW Mission Package.....	28
Figure 8. MIW Mission Package Components.....	28
Figure 9. MIW Mission Package.....	29
Figure 10. SUW Mission Package Components.....	29

TABLES

Table 1. LCS Variant Comparison.....	4
--------------------------------------	---

Executive Summary

Title: Littoral Combat Ship: Is it a Blue-Green Asset?

Arthur: Lieutenant Commander Fiona Halbritter, United States Navy

Thesis: The Littoral Combat Ship with its transformational, modular, open architecture design supports Marine Corps warfighting functions and has the potential to be an asset for future operations such as sea basing and distributed operations.

Discussion: The post-cold war strategic environment has lead to an increase of naval operations in littoral waters. The current fleet consists of large, expensive multi mission ships that are poorly suited to operate in coastal waters. In the late 1990s the Navy developed a concept of small, fast, networked and modular ships to engage the challenges of the littoral environment. The Littoral Combat Ship (LCS) was designed with an open architecture and mission bay to allow a diverse assortment of mission packages. The LCS can be re-configured with different mission packages to counter determined threats. The benefits of this flexibility abound for the Navy, but it will also contribute to the Marine Corp mission. This study analyzes the ability of the LCS to support the Marine Corp warfighting functions and operations of the future.

Conclusion: The Littoral Combat Ship was designed to meet Navy mission capabilities. The LCS will support USMC missions by providing littoral security. The LCS is an ideal platform for a naval fire support mission package. This capability would directly support USMC warfighting functions and future missions including distributed operations.

INTRODUCTION

In the 1990's the US Navy determined that a new ship class which is affordable and adept in littoral conditions is required to implement current and future expeditionary missions. This ship must be able to counter specific challenges of operating in the littorals while maintaining sea superiority. Threats will continue to evolve quickly in a littoral environment requiring adaptability from the Navy. The Littoral Combat Ship (LCS) is designed to meet these requirements. The LCS is designed to operate in the taxing brown water areas, be affordable and have the flexibility to meet changing threats.

LCS is one of many assets that will help to enable the Navy's Sea Power 21 vision. Sea Power 21 has three fundamental concepts: Sea Strike, Sea Shield and Sea Basing. These three concepts are united through a Force Net. Force Net provides an architectural framework to integrate platforms, sensors, and weapons creating a distributed, networked combat force.¹ The LCS design has a networked architecture at its core and supports efforts of the Sea Shield concept while embracing Force Net.

LCS is designed to contribute to the Sea Power 21 concept, however its use in littoral waters encourages us to examine how the LCS will impact USMC missions. The Littoral Combat Ship with its transformational, modular, open architecture design supports Marine Corps warfighting functions and has potential to be a vital asset for future operations such as sea basing and distributed operations.

THE LITTORAL COMBAT SHIP CONCEPT

The idea for small ships capable of littoral operations began in the late 1990s. The late Vice Admiral Arthur Cebrowski published an article in *Proceedings* defining the future naval

operating environment and proposing a new type of naval ship to meet these challenges.² His vision included adding a force of small ships that were fast, networked, modular, utilized unmanned vehicles, austere manned and affordable to the existing fleet.³ He called this concept *Streetfighter*, and sold the idea to then CNO Admiral Clark in 2000.⁴ The Littoral Combat Ship program office was established in 2002 and work began to develop an optimal design and define the ship's specific missions. The program office determined that the LCS primary missions would include Anti Submarine Warfare (ASW), Mine Warfare (MIW) and Surface Warfare (SUW) with an emphasis on small boat defense. Secondary missions identified were Maritime Interdiction Operations (MIO), Special Operation Force (SOF) insert and support, and Command, Control, Communication, Computer, Intelligence, Surveillance and Reconnaissance (C4ISR).⁵

The *Streetfighter* concept had a varied reception within the naval community. Many agreed that the current force was not well suited for littoral operations but were skeptical about a small single mission focused ship. Initial reaction highlighted the possibility of operating close to an enemy's coast with strike weaponry and the capability to support Marines ashore.⁶ There was also speculation about export potentials and support to the U.S. Coast Guard.⁷ Not all readily welcomed the idea of adding a fleet of small ships to the Navy. There are fears that "an over-reliance on the littoral combat ship could leave us vulnerable to nations with deep water capabilities."⁸ In the early 19th century, the U.S. Navy focused primarily on coastal operations with small gunboats to defeat piracy and lost some capability to conduct open ocean operations. The smaller coastal U.S. Navy realized its mistake when faced and defeated by a balanced British Navy in the war of 1812.⁹ Lessons learned from this period emphasized the importance

of maintaining sea superiority in order to protect the littoral ships and provide presence and deterrence.¹⁰

These concerns were addressed while refining the *Streetfighter* concept. It was decided that the small littoral combatant ship class would become part of the new Surface Combatant Family Of Ships (SCFOS). The SCFOS would be comprised of the current model of AEGIS destroyers and cruisers and the next-generation destroyer (DD(X)) and cruiser (CG(X)) augmented by the LCS.¹¹ The networked LCS will enhance the capabilities of the multi-mission combatants by countering anti-access threats in the littorals.¹² The LCS gives the Navy a ship capable of conducting littoral operations and coupled with the rest of the SCFOS, sea superiority will be maintained. Sea power will be increased through the networked ability of the SCFOS. The SCFOS concept and more specifically the *Streetfighter* concept has become reality with the production of the LCS. However, the SCFOS concept is in jeopardy. The CG(X) program has been canceled and the DD(X), now the DDG-1000 Zumwalt class has been limited to three ships.¹³ These upsets to the SCFOS concept have not yet impacted the LCS program. For the immediate future, the LCS will operate with the current AEGIS cruisers and destroyers to provide sea superiority. The LCS design is critical in ensuring it can function within a littoral environment. The Navy chose two designs and has built each to see which will best suit mission requirements.

LCS DESIGN

In line with the new transitional acquisition strategy, the LCS contract was awarded to two different companies. General Dynamics and Lockheed Martin have both manufactured separate LCS seaframes.¹⁴ Each ship design meets the LCS mission specifications and testing is

scheduled to determine which design best meets the Navy's requirements. The Lockheed Martin LCS (LCS-1 *Freedom*) design is based on a predominately steel framed mono-hulled ship¹⁵ seen in figure 1 and 2 (Appendix A).¹⁶ The General Dynamics design (LCS-2 *Independence*) is a trimaran made from aluminum¹⁷ displayed in figures 3 -5 (Appendix A).¹⁸ Both ship designs have a mission bay capable of carrying the modular mission packages and a large flight deck with a hangar bay.¹⁹ Specific data on the separate seaframe designs are contained in the table below.

Table 1²⁰

LCS Seaframe Variant Specifics

	Lockheed Martin	General Dynamics
Displacement:	3,089 tons, full load	2,790 tons, full load
Dimensions, feet (metres):	379.0 × 43.0 × 12.8 (115.5 × 13.1 × 3.9)	417.3 × 99.7 × 14.8 (127.2 × 30.4 × 4.5)
Main machinery:	CODAG: 2 Rolls Royce MT-30 gas turbines; 96,550 hp (72 MW); 2 Fairbanks Morse Colt-Pielstick 16PA6B diesels; 17,160 hp (12.8 MW); 4 Rolls Royce Kamewa 153SII waterjets	CODAG: 2 gas turbines, 2 diesels; 4 steerable waterjets; 1 steerable thruster
Speed, knots:	45	45
Range, n miles:	3,500 at 18 kt	4,300 at 18 kt
Complement:		40
Missiles:	Raytheon RAM	Raytheon RAM
Guns:	1 United Defence 57 mm/70 Mk 2; 220 rds/min to 17 km (9 n miles); weight of shell 2.4 kg. 4-12.7 mm MGs	1 United Defence 57 mm/70 Mk 2; 220 rds/min to 17 km (9 n miles); weight of shell 2.4 kg. 4-12.7mm MGs
Countermeasures:	2 SKWS/SRBOC decoy launching systems. WBR 2000 ESM	Decoys: ESM/ECM EDO ES 3601 ESM
Combat data systems:	COMBATSS-21	Northrop Grumman Electronic Systems Integrated Combat Management System (ICMS)
Weapons control:	To be announced	TACTICOS
Radars:		
Air/surface search:	EADS TRS-3D; C-band	Ericson Sea Giraffe; G/H-band
Navigation:	NAVSSI/GPS/WSN7V	Sperry Bridgemaster
Fire control:	DORNA EOD EO/IR System	SEASTAR SAFIRE III EO/IR
Sonars:	None	None
Helicopters:	2 MH-60 R/S helicopters or 1 MH-60 R/S and 3 Firescout VTUAVs	2 H-60 helicopters; multiple UAVs/VTUAVs.

The LCS concept calls for both ship designs to meet requirements while maintaining affordability allowing the fleet to produce numerous ships. This has not been the case. The price for each prototype built has already doubled from the original estimate.²¹ The LCS was intended to cost \$220 million each permitting the long term budget to include 55 LCS's built in the next 30 years.²² LCS 1 *Freedom*'s final cost is \$637 million and the LCS 2 *Independence* is \$704 million.²³ The Navy continues to support the LCS design and concept as reflected by Bush administration Secretary of the Navy Donald C. Winter's comments, "We are encouraged by the products we are seeing from the LCS program, but we are disappointed in the cost and schedule overruns. Our objective is to build 55 ships in a timely, cost-effective manner."²⁴ In an attempt to gain control of costs, a price cap of \$460 million per each ship was imposed in 2009.²⁵ Both Lockheed Martin and General Dynamics stated difficulties in meeting this cost cap.²⁶ The final contract for Lockheed Martin's LCS 3 was awarded at \$470,854,144 and General Dynamic's LCS 4 at \$433,686,769.²⁷ Both LCS 3 and 4 contracts exclude government expenses such as government furnished equipment, change orders and program support costs as well as the cost of continuation work and material used from the original contract options for LCS 3 and 4.²⁸ These costs are more than \$192 million dollars.²⁹

Although the objective of a timely cost-effective production is not currently being met, then Navy Secretary Winters continued to support the program in 2008, "Our 30-year shipbuilding program — which already reflects our plans for LCS —is unchanged."³⁰ The 2005 30-year shipbuilding plan called for twenty two LCS to be ordered with seven in the Fleet by the end of FY 2010.³¹ This plan is far behind schedule with only four LCS's ordered and two in the Fleet by mid FY 2010. LCS-1 *Freedom* was originally to be delivered in early 2007³², the Navy commissioned LCS-1 on November 8, 2008 more than a year behind schedule. Despite these

schedule and cost delays the Navy is still committed to the LCS program in full within a 313 ship plan.

Budget difficulties and schedule delays with the LCS will have an impact on the fleet.

The mine and antisubmarine warfare capabilities of the LCS are vital to fill mission capability gaps. Mine warfare is currently conducted by the 14 MCM Avenger class ships with MCM-1 commissioned in 1987.³³ The final MHC Osprey class ships were decommissioned in 2007.³⁴

The U.S. Navy still operates 30 Oliver Hazard Perry class FFGs with a primary mission of antisubmarine warfare. These FFGs are aging quickly. The first FFG was commissioned in 1977 with the newest ship commissioned in 1989.³⁵ The plan to replace aging mine countermeasure ships and Frigates with LCS will need adjustment in response to delays.³⁶ This may influence the missions that LCS is tasked with as it begins to enter the fleet.

MODULARITY

Responding to concerns regarding the limited utility of a small vessel, the LCS is the first ship in the fleet with a modular design. Modular capability has increased importance in recent years. Rapid advancements in technology can quickly leave ships dated. Lengthy and expensive shipyard alterations are required to update ships. A ship built with modular design can avoid the expense and time in shipyards to obtain rapid upgrades.³⁷ This modular design allows a ship to "remain at a high state of technological readiness throughout its service life, which should extend well beyond the average service life of current generation ships."³⁸

Modularity has been identified as necessary for flexibility within the fleet. The LCS will demonstrate the benefits of a modular design. Rear Adm. Don Loren has identified 3 advantages to modularity:

- 1) Throughout the acquisition cycle, new mission modules can be installed during ship construction without significant non-recurring engineering to the basic ship.
- 2) The ability to rapidly reconfigure the mission modules will enable the naval or joint force commander to tailor the LCS for the anticipated threat.
- 3) Mission modules will be replaced without putting the ship in dry-dock for extended periods of time, cutting holes in the side of the ship, or running lengths of cables and piping throughout the ship.³⁹

A fleet with ships that have the above capabilities provide the navy with flexibility of mission, time and technology. It also reduces risk taken by the Navy. New systems can be evaluated without investing in an entire new ship.⁴⁰ Time required to install new technology is reduced, getting capabilities to the fleet when needed. These benefits will allow LCS to be used for various missions. In 2004, then Chief of Naval Operations Admiral Vern Clark stated,

It will be the first Navy ship to separate capability from hull form and will provide a robust, affordable, focused-mission ship to enhance our ability to establish sea superiority not just for our Carrier Strike Groups and Expeditionary Strike Groups, but for all the joint logistics, command and control and pre-positioned ships that must transit the critical littoral threat area to move and support forces ashore.⁴¹

Modularity allows LCS to tackle anticipated missions and the ability to adapt to meet any unforeseen missions in the future.

LCS PROS AND CONS

LCS has many eyes on it as the first modular ship in the Navy and also the first new ship class of the SCFOS concept. The new technology and transitional concept behind LCS lends it to be used differently than conventional combatant ships. Single mission ships operating in squadrons will require doctrine and philosophical change for the Navy. So how does LCS benefit the navy mission? Below are some of the benefits and obstacles of the LCS:

PROS

Economical
Quickly built
Optimum manning
Shallow draft
High speed
Modular
Networked

CONS

Extremely over budget
Rotational crews
Contracted maintenance
Tailored training plan
Single mission capability
Mission package dependency
Minimum Self Defense

LCS pros consist of conventional advantages and transitional notions. Some of these notional benefits are falling short and becoming negatives to the project. Price and schedule have both fallen short in actuality. The first ship built in any class of ship is expected to be more expensive however LCS has exceeded inflated cost predictions. This is in part due to a change in design requirements from the original concept requiring more durable hulls. The first LCS was completed in six years being built much quicker than conventional surface combatants however it was still nearly two years behind schedule. Concentration on automated systems and unmanned vehicles allows the LCS to have an optimal manning of less than 50 personnel. This is a significant reduction in operating man-power costs for a surface combatant in comparison with frigates manned by 210 personnel, 276 on a destroyer and 364 on a cruiser.⁴² The benefit of lower manpower costs is countered by the requirements for rotational crews, specific tailored training programs for each crew member and contracted maintenance.⁴³ The effect of rotational crews on ship performance, maintenance and longevity are currently still under research. LCS optimal manning requires each crew member to have specific abilities. These crew members will have a specific training plan created for them, in addition the two different LCS designs will require separate training plans. The small crew size will not be able to perform all the preventative maintenance requirements for the ship. A new system to accomplish maintenance

on LCS has to be established. Utilizing contractors or creating a naval shore maintenance infrastructure are options but will cost.⁴⁴

Other cons to the LCS concern its single mission focus. The LCS only has the ability to carry one mission package at a time. This is not a problem if the threat environment is accurately predicted or there are accompanying ships with the LCS that have other mission capabilities. If this is not the case, an LCS is left with minimal self defense means. An LCS can change mission packages within three days however that does not include transit time to and from an installation place. A RAND study has suggested five ports as installation sites; Norfolk, San Diego, Japan, Singapore and Bahrain.⁴⁵ The supply of mission packages and ability to install the needed package for each mission is a risk that the Navy has not had to accept while operating multi-mission ships.

CURRENT MISSION PACKAGES

As noted, the LCS has three primary mission areas: ASW, MCM and SUW. These mission areas are the basis for the first three mission packages to be used with LCS. The mission package interfaces with the LCS through the Mission Package Computing Environment (MPCE).⁴⁶ All three mission packages will include a type of MH-60 helicopter and the MQ-8B Fire Scout, an unmanned vertical take-off aerial vehicle.⁴⁷ A fundamental goal for the mission packages is to maximize utilization of unmanned vehicles and reduce manning requirements. Mission packages are designed to be operated with a detachment of 15 sailors. An additional 23 personnel will man an aviation detachment to support MH-60s.⁴⁸ All mission packages are networked to ensure sensor and weapon data are provided to other SFCOS ships in the operating

area. Each LCS can be outfitted with any of the mission packages. Re-configuration of an LCS from one mission package to another is designed to take one to four days.

The three current mission packages will be tested on both LCS prototypes. This testing will ensure both seaframes interface correctly with the mission packages and also that each mission package is capable of conducting requirements on both seaframes. Complex naval schedules will likely require mission packages to be tested on various LCS seaframes.

Anti-Submarine Warfare Mission Package

The ASW mission package is designed to counter the quiet diesel submarine threat in littoral operating areas. This mission package includes an unmanned surface vehicle capable of towing an active and passive acoustic array, dipping sonar, unmanned underwater vehicle and torpedoes (see figures 6&7 Appendix A). The helicopter assigned to an LCS used for ASW will be an MH-60R which is capable of submarine detection and engagement.⁴⁹

The capabilities of the ASW mission package will allow an LCS to be utilized in several ASW roles. The intrinsic network ability of the LCS will allow it to lay a sensor grid in coordination with other LCS or SCFOS ships for barrier, choke point or prosecution operations. They will also add to the ASW common operational picture to support strike group operations. The ASW mission package allows littoral waters to be monitored for submarines without bringing a large destroyer or cruiser into a restrictive environment or using an aging frigate for submarine prosecution.

Mine Counter Measure Mission Package

Dedicated Mine Counter Measure (MCM) platforms are declining in the navy. The Osprey class MHCs were decommissioned and the Avenger class MCMs are aging. Dedicated MCM helicopters, the MH-53E will reach the end of their expected life cycle by 2012.⁵⁰ The

LCS with a MIW mission package will play a centered role in replacing these assets. The MIW mission package centers on the WLD-1 remote multi-mission vehicle (see figures 8&9, Appendix A). This un-manned vehicle operates under the surface of the water exposing only a mast and carries mine counter measure systems.⁵¹ An MCM outfitted LCS will carry a MH-60R helicopter which is capable of five different mine counter measure systems.⁵² They will also utilize the Remote Minehunting System (RMS).

The MCM mission package allows the LCS to be employed in three MIW areas. First the ship will be able to establish an undersea picture/awareness. This will be done by mapping the sea bottom, or developing a Q route (established mine free route). The MCM package is also designed to allow for the prosecution of enemy mine layers. The networked sensors allow the LCS to coordinate with a strike group to intercept a vessel identified as laying mines. Lastly the MCM package allows the LCS to search, map and neutralize mines. The LCS excels over the old MHC and MCM ships with its capability for greater self-sustainment and ability for a rapid response.

Surface Warfare Mission Package

The surface warfare mission package is designed to counter small fast surface ships found in the littoral environment. The mission package includes two mk50 30mm rapid-fire guns. Another surface module includes the Non-Line-Of-Sight Launch system which fires the Precision Attack Missile.⁵³ The MH-60R helicopter supports surface warfare with the detection and engagement of surface contacts. Another module of this mission package is the maritime security module. This includes two boarding teams, boat crews and Rigid-Hull Inflatable Boats (RHIB). The surface mission package will also have deployable sensors to increase the surface common operational picture and provide early warning of surface craft (figure 10, Appendix A).

An LCS with a surface package can be employed in numerous ways. The ship itself and deployed sensors will provide early warning to all ships within its network. Once a vessel of interest is identified, the LCS can be used to intercept, screen, distract or deceive the target. The LCS can accomplish these tasks with the ship itself, helicopter detachment, UAV, coordinated with other ships or any combination of the listed. This ability can be used to support a strike group, force protection to a sea base or support to other LCS ships in a different mission role.

The SUW mission package has begun engineering testing on LCS 1 *Freedom*. All developmental testing should be complete by early 2011 with operational testing to follow and be complete in 2012.⁵⁴ LCS 1 *Freedom* deployed in early 2010 with a modified SUW mission package onboard. This mission package included a maritime security module and only two 30mm guns instead of the planned Non-Line-Of-Sight missile system.⁵⁵

POSSIBLE MISSION PACKAGES

The *Streetfighter* concept which began the LCS program envisioned a variant with the speed and payload to make it a Navy-Marine Corps asset for sustaining operations from the sea and operational maneuver from the sea (OMFTS).⁵⁶ The Navy began development of LCS mission packages in three areas to fill naval mission capability gaps. These mission packages do not support a Navy-Marine Corps LCS, however open architecture and modularity make it possible to develop and install new mission packages quickly converting the LCS into a blue-green asset.

The LCS concept of operations is already looking at additional modules/mission packages to enhance the LCS's ability to conduct identified secondary missions. These capabilities may be used on an LCS within a squadron or for independent operations. Modules

in consideration are: SOF support, Maritime Security, Force Protection, Medical and Noncombatant Evacuation Operation (NEO) / Humanitarian Assistance (HA), and logistics and sea basing.⁵⁷

Future Naval Mission Packages

Special operations are vital in 21st century warfare. All services have special operation forces. LCS has potential to provide transport, access and support to special operation forces. The Navy foresees this mission package embarking a Navy Special Warfare Task Unit (NSWTU) of 80 SEALs, a special boat squadron detachment, support personnel and two 11 meter RHIBs. Extra command and control equipment will amplify LCS installed C4ISR capabilities. This package would give LCS the capability to conduct beach surveys, Visit, Board, Search and Seizure (VBSS) missions and operate a Swimmer Delivery Vehicle (SDV).⁵⁸ While the Navy is focusing on a SOF package to support SEALs, versatility can be built into the package to support the special operation forces from all services.

Maintaining sea superiority is essential to the Sea Power 21 concept. Maritime Interdiction Operations (MIO) are elemental to maritime security. A maritime security module to support MIO is in development and onboard LCS 1 *Freedom*. The Navy plans on increasing the size and capabilities of this module to enhance the LCS ability to conduct independent MIO.⁵⁹ Elements of this mission package include boarding party detachments, RHIBs, weapon and support equipment, and additional command and control equipment.⁶⁰ Both LCS seaframes do not include berthing area for the additional personnel required to conduct MIO. The MIO mission package would include temporary berthing areas established in the mission bay. The additional personnel and equipment coupled with the inherent LCS capabilities, helicopter and UAVs will allow LCS to conduct permissive and hostile MIO.

Maritime security continues from the high seas through the littorals and into ports providing force protection. A force protection module for the LCS would include a security force, 11m RHIBs, working dogs, boarding parties, and EOD personnel with a mammal pool. This package will be capable of providing protection to other ships, survey transit routes, provide advanced personnel to liaison with national authorities and provide landward and seaward security to ships in port.⁶¹ USMC will benefit from the added protection to marines onboard amphibious ships. Additionally, LCS embarked force protection units could be delivered to coastal areas in support of USMC operations.

Military Operations Other Than War (MOOTW) such as NEO, HA and medical evacuation play an important role for the United States world image. Globalization and technological advancements have put MOOTW operations under immediate scrutiny. LCS has the potential to improve U.S. response capabilities. A MOOTW mission package could include radiological services, medical laboratory, mobile oxygen producing plant, four semi-trailer hospital bed facilities, six semi-trailers with operating rooms, four water tanker, four food trailers, four toilet/shower trailers, six HMMVV and eight to twelve passenger buses.⁶² Historically the USMC is the first responders for MOOTW operations. The USMC will benefit from the additional support equipment and facilities that an LCS can bring to an operation. Furthermore, these capabilities can be leveraged to support the USMC during wartime operations.

Sea Basing / Logistical Support

Sea basing is one of the three pillars of Sea Power 21. It is a decisive concept for future joint operations. Sea basing provides enhanced capabilities for logistical support to both naval units and forces ashore. LCS will likely contribute significantly to logistical/sea basing

operations. The LCS design and mission packages are ideal for countering threats to a sea base and protecting craft in transit between the sea base and shore. In addition to this security role, the LCS concept of operation notes, "The LCS potential to rapidly transport up to a battalion and its combat equipment in one trip is of great advantage to a combatant commander."⁶³ This ability to transport from a sea base to port far exceeds the capacity of current amphibious craft and speed of amphibious shipping. The USMC has recognized this potential in the LCS, noting in the Marine Corps Gazette;

The ship provides one of the largest usable payload volumes of any U.S. Navy surface combatant-up to 58 HMMWVs or the equivalent-enabling it to carry more weapons payload per ton of displacement than any other U.S. Navy combatant ever built.⁶⁴

LCS has some limitations compared to current landing craft. The LCS does not have the ability to land on a beach to offload a payload. LCS would require a dock to offload. A shallow draft allows LCS to enter into austere ports. Speed and a sizeable payload may offset this limitation in some situations.

The LCS has not begun testing with USMC personnel and equipment; however joint tests have been conducted on a similar platform, the High Speed Vessels (HSV). HSVs have comparable payload space and operating speeds as the LCS. Testing with the HSV has shown increased on load/ off load tempo with reduced vulnerability and Marine combat power is kept intact.⁶⁵ The Army and Navy have developed a Joint HSV (JHSV) to conduct "fast intra-theater transportation of troops, vehicles and equipment."⁶⁶ The JHSV will be capable of transporting a payload of 700 short tons over 1,200 nautical miles. The catamaran design of the JHSV gives it a shallow draft that also allows it to enter austere ports for onload and offload. The contract for the first JHSV was awarded in 2008 for \$185 million and the ship is scheduled to be built by November 2010.⁶⁷ If maintained, this low cost and rapid production makes the JHSV a prudent

choice to facilitate speedy ship or sea base to shore transportation and would be a complementary capability to the LCS.

On top of the sizable payload for transport, the LCS also has a large flight deck. The flight deck cannot support the new USMC MV-22 Osprey, but it can be configured to support lily pad operations for the CH-53.⁶⁸ The combined payload and flight deck capabilities of the LCS can provide the USMC numerous options for Ship To Objective Maneuver (STOM). The decision then must be made to outfit an LCS with a mission package to counter littoral threats, or to maximize payload area for USMC use leaving the LCS with only self-defense capabilities. Modularity allows for some LCS to be configured for logistics/sea basing/STOM operations while the rest of the squadron has a mix of MIW/ASW/SUW mission packages to enhance combat power and security in the littorals.

Fire Support

In addition to these navy envisioned packages the opportunity exists for the USMC to request a capability. The Commandant of the Marine Corps, Gen. Conway visited the LCS seaframes and stated that he "saw a lot of potential for the two ships."⁶⁹ Although the USMC is interested in the LCS they have not expressed an official requirement.⁷⁰ Gen. Conway indicated the USMC desire to introduce a fire-support capability to the LCS⁷¹ and the Navy admits to the possibility with caveats. The current Non-Line-Of-Sight (NLOS) launch system with its precision attack missiles does not support long ranges desired by the USMC.⁷² The modular, open architecture design of the LCS retains the possibility for technical improvements to the launch system or the introduction of a new system that would support USMC fire-support requirements.

The SCFOS concept calls for the DD(X) to provide fire support. DD(X) has evolved into the DDG 1000 Zumwalt class destroyer. Cost constraints have severely restricted the Navy's production plan for the DDG 1000. Current plans procure only 3 DDG 1000 ships. The 155mm Advanced Gun System with its Long Range Land Attack Projectile (LRLAP) will extend fire support from ships out to 70 miles.⁷³ The Arleigh Burke class DDG with its MK 45 5-inch / 54-caliber gun only has a range of 15 miles. The upgraded MK 45 5-inch / 62-caliber gun utilizing Extended Range Guided Munition (ERGM) has a range of 40-60 miles, but the Navy has canceled the program due to cost and reliability issues. The new 155mm Advanced Gun System (AGS) is a capability that the Navy and USMC desires. LCS with its modular design is an economical option to outfit with a fire support package containing the 155mm AGS and LRLAP.

LCS SUPPORT TO DISTRIBUTED OPERATIONS

Distributed operations is a concept for future USMC operations. This concept calls for USMC units to be dispersed throughout a large area to obtain a spatial advantage and still utilize close combat or supporting arms to disrupt the enemy.⁷⁴ This concept will require more support from joint fires than is currently seen in operations. Distributed USMC units would rely on network centric warfare to enable them to operate independently. Network centric warfare is also an essential attribute for LCS. Networked marines and ships will be capable of sharing a common picture. Maintaining an accurate real-time situational awareness will be vital for command and control in a distributed operating environment. The common picture will be seen by maneuver, intelligence, fire and logistic elements to maximize effectiveness of the force.⁷⁵

LCS will be able to support both aggregated and distributed Marine forces. The shallow draft of LCS allows it to enter more coastal waters than conventional amphibious shipping. This

provides the opportunity for logistical and fire support once those LCS mission packages are developed. The networked capabilities of LCS will provide a common picture to all forces enhancing situational awareness while supporting STOM throughout the extended battle space of distributed operations.⁷⁶

Another key element of distributed operations that LCS supports is sea basing. USMC units will not be able to provide force protection for large shore support structures when dispersed throughout a large operating area. The flexibility to provide logistical support to distributed units through sea basing reduces force protection requirements ashore.⁷⁷ LCS with its current mission package is already capable of providing force protection to the sea base and has the potential to augment logistical flow with the development of logistical mission packages.

CONCLUSIONS

The Littoral Combat Ship began as a naval vision to meet changing strategic demands. LCS is an asset to achieve Sea Shield of the Sea Power 21 vision. The transformational modular, open architecture design avails the LCS to mature into much more than its original concept calls for. This design flexibility has already made the ship an attractive export interest to foreign navies. Within the United States, the LCS will branch out of strictly naval mission areas to support joint warfare. The logical first step to multi service support is with the USMC. The USMC operates within the littoral environment and has historical collaboration with the Navy. LCS with its current three mission packages will enhance the Navy's ability to support amphibious operations and sea basing while supporting the USMC's warfighting functions. Furthermore, LCS will play an important role in the USMC concept for distributed operations. Future mission packages to support USMC maneuver and fire-support are probable.

Naval threats in the littoral environment have defined the three primary mission areas for the LCS. ASW, MCM and SUW mission packages ensure sea superiority is obtained in coastal waters. This benefits the USMC by granting access through hostile enemy littorals and adds maneuver and logistic flexibility. Moreover, the LCS inherent seaframe capabilities for C4ISR and unmanned vehicles will assist the USMC with intelligence and command and control. The LCS as currently designed and used for naval missions will support but not enhance USMC warfighting functions.

The Navy is already exploring future modules and mission packages to utilize on LCS. Former secretary of the Navy stated, "...the idea of putting on modules to enable amphibious warfare seems a logical extension of these capabilities."⁷⁸ The Navy foresees USMC interest in LCS,

the fact you have a good-sized flight deck and hangar in both variants, as well as the ability to deploy small boats, gives you some tremendous potential from the standpoint of amphibious operations, which is a core Marine Corps interest area.⁷⁹

The USMC has not made an official request for additional LCS capabilities, but comments have been made about fire-support and movement potential. Current onboard fire systems will not meet the USMC requirements, however the unique design of the LCS make it possible to quickly install new launch system technology as it is developed that will support long-range fire support missions. Personnel and equipment transportation has not been tested yet onboard the LCS but experimentation has been done onboard the HSV with promising results. Lessons learned from those tests will aide in the development of LCS into an adept, fast, large transport for up to a brigade to support OMFTS.

Future USMC operations include maximum use of a distributed force. The LCS is an optimal platform to support these operations. High speed allows the LCS to rapidly move

Marines and equipment to distant positions within the operational area. The networked platform will contribute to the common picture to aid situational awareness and command and control. The possible development of a fire-support package would augment the availability of ship provided fire-support to dispersed units.

LCS has the potential to be an asset to the USMC as well as the Navy. There are several barriers which may prevent the LCS from becoming a blue-green asset. Cost and schedule delays plaguing LCS will limit the availability of the ship to assist in USMC missions. The Navy will use LCS in the ASW, MCM and SUW mission areas to provide security to CSGs, ARGs and in choke points. The addition of a JHSV to the fleet will provide a more affordable option for USMC maneuver in the littorals. Naval fire support is an area that is still inadequate. A naval fire support solution must be found that is cost effective. The modular LCS is an obvious choice. An LCS with a Fire Support mission package is the USMC/USN LCS variant for the future.

The ability to operate in the littorals and the modular design provides opportunity for the LCS mission to expand. Brigadier General Hanifen commented that the LCS is very capable with a large open bay and flexible mission modules.⁸⁰ The USMC will continue to monitor the LCS and mission module development. There is possibility for a Marine Corps-specific module for future operations.⁸¹

¹ Vern Clark, "Sea Power 21," *U.S. Naval Institute Proceedings*, October 2002, <http://www.navy.mil/navydata/cno/proceedings.html> (accessed February 4, 2010).

² Duncan Long and Stuart Johnson, *The Littoral Combat Ship From Concept to Program*, Case Studies in Defense Transformation. Number 7 (Center for Technology and National Security Policy, 2007), 3, <http://www.ndu.edu> (accessed January 9, 2010).

³ Duncan Long and Stuart Johnson, 7-8.

⁴ Duncan Long and Stuart Johnson, 11.

⁵ Duncan Long and Stuart Johnson, 12.

⁶ Vago Muradian, "Future Navy may have Small Tough Ships to Support Marines," *Defense Daily* 201, no. 36 (February 1999): 1. <http://www.proquest.com/>.

⁷ Vago Muradian, 1.

⁸ Eric Kimura, "A Gunboat Navy for the 21st Century," *U.S. Naval Institute Proceeding*, July 2005, 44, <http://www.proquest.com/>.

⁹ Eric Kimura, 45-46.

¹⁰ Eric Kimura, 45-46.

¹¹ Edward Lundquist, "One Ship Can't Do It All," *NATO's Nations and Partners for Peace*, no. 3 (2004): 130, <http://www.proquest.com/>.

¹² Edward Lundquist, 131-135

¹³ Christopher Cavas, "Defying Trend, DDG 1000 on Time, Budget," *Defense News*, August 17, 2009, <http://search.ebscohost.com/>.

¹⁴ Otto Kriesher, "Littoral Combat Ship (LCS) Production Problems Threaten The U.S. Navy's LCS Programme," *Naval Forces* 30, no. 2 (2009): 28, <http://search.ebscohost.com/>.

¹⁵ Otto Kriesher, "Littoral Combat Ship (LCS) Production Problems," 28.

¹⁶ U.S. Navy, Team Ships, <http://peoships.crane.navy.mil/lcs/Lockheed.htm/>.

¹⁷ Otto Kriesher, "Littoral Combat Ship (LCS) Production Problems," 28.

¹⁸ U.S. Navy, Team Ships, <http://peoships.crane.navy.mil/lcs/GeneralD.htm/>.

¹⁹ Otto Kriesher, "Littoral Combat Ship (LCS) Production Problems," 28.

²⁰ U.S. Navy, Team Ships, <http://peoships.crane.navy.mil/lcs/factsheet.htm>

²¹ Otto Kriesher, "Littoral Combat Ship (LCS) Production Problems," 28.

²² Otto Kriesher, "LCS Commitment," *Seapower*, March 2008, 56, <http://search.ebscohost.com/>.

²³ Christopher Cavas, "New Littoral Ship Prices To Be Revealed," *Defense News*, October 7, 2009, <http://search.ebscohost.com/>.

²⁴ Otto Kriesher, "LCS Commitment," 56.

²⁵ Christopher Cavas, "New Littoral Ship Prices To Be Revealed."

²⁶ Christopher Cavas, "New Littoral Ship Prices To Be Revealed."

²⁷ US News Service, "Navy Announces Contract Award Values For Littoral Combat Ships 3, 4," *Washington DC US News Service, Including US State News*, December 5, 2009, <http://search.ebscohost.com/>.

²⁸ US News Service, "Navy Announces Contract Award Values For Littoral Combat Ships 3, 4,"

²⁹ US News Service, "Navy Announces Contract Award Values For Littoral Combat Ships 3, 4,"

³⁰ Otto Kriesher, "LCS Commitment," 56.

³¹ Otto Kriesher, "Checkered Past, Uncertain Future," *U.S. Naval Institute Proceeding*, January 2009, <http://search.ebscohost.com/>.

³² Scott C Truver, "Taking Back the Littoral: US Navy Littoral Combat Ship Programme Update...And More!" *Naval Forces* 27, no. 3 (2006): 68, <http://search.ebscohost.com/>.

³³ US Navy, United States Navy Fact File, http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=1900&ct=4.

³⁴ Fifi Kieschnick, "Final Four MHCs Decommission," US Navy, http://www.navy.mil/search/display.asp?story_id=33653

³⁵ US Navy, United States Navy Fact File, http://www.navy.mil/navydata/fact_display.asp?cid=4200&ct=4&tid=1300.

³⁶ Otto Kriesher, "Littoral Combat Ship (LCS) Production Problems," 28.

³⁷ Don Loren, "Littoral combat ships will help U.S. Forces gain access," *National Defense* 87, no. 589 (December 2002): 20-21, <http://www.proquest.com/>.

³⁸ Don Loren, 20.

³⁹ Don Loren, 20

⁴⁰ Don Loren, 20-21.

⁴¹ Admiral Clark, quoted in Edward Lundquist, "One Ship Can't Do It All".

⁴² US Navy, United States Navy Fact File, http://www.navy.mil/navydata/our_ships.asp.

⁴³ Geoff Fein and Terrance Etnyre, "Surface Warfare Enterprise Tackling LCS Manning, Training Challenges," *Defense Daily* 233, no. 11 (January 2007): 1, <http://www.proquest.com/>.

⁴⁴ Geoff Fein and Terrance Etnyre, "Surface Warfare Enterprise Tackling LCS Manning, Training Challenges,"

⁴⁵ US Navy. *Littoral Combat Ships: Relating Performance to Mission Package Inventories, Homeports, and Installation Sites*, by Brien Alkire, John Birkler, Lisa Dolan, James Dryden, Bryce Mason, Gordon T. Lee, John F. Schank and Michael Hayes. Santa Monica, CA: RAND National Defense Research Institute, 2007, 75.

⁴⁶ Otto Kriesher, "LCS Commitment," 58.

⁴⁷ Richard Burgess, "Mission Takes Shape: Commissioning Awaits *Freedom, Independence* Readies for Sea Trials," *Seapower*, October 2008, 17, <http://www.proquest.com/>.

⁴⁸ Richard Burgess, 19.

⁴⁹ Richard Burgess, 18.

⁵⁰ Paul Ryan, "LCS Will Transform Mine Warfare," *U.S. Naval Institute Proceeding*, December 2004, 37-39, <http://search.ebscohost.com/>.

⁵¹ Richard Burgess, 18.

⁵² Richard Burgess, 18.

⁵³ Richard Burgess, 18.

⁵⁴ Richard Burgess, 19.

⁵⁵ Cid Standifer, "Freedom To Head South With First Surface Warfare Mission Package," *Insidedefense.com*, December 14, 2009, http://insidedefense.com/secure/display.asp?docnum=NAVY-22-49-13&f=defense_2002.ask (accessed January 9, 2010).

⁵⁶ A. K. Cebrowski and Wayne Hughes, "Rebalancing the fleet," *U.S. Naval Institute Proceedings*, November 1999, 31, <http://www.proquest.com/>.

⁵⁷ Navy Warfare Development Command, *Littoral Combat Ship Concept of Operations*, V3.1 (February 2003), <http://www.globalsecurity.org/military/Library/report/2003/LCSCONOPS.htm#OperationalConcept> (accessed January 9, 2010).

⁵⁸ NWDC, *LCS Concept of Operations*.

⁵⁹ Cid Standifer.

⁶⁰ NWDC, *LCS Concept of Operations*.

⁶¹ NWDC, *LCS Concept of Operations*.

⁶² NWDC, *LCS Concept of Operations*.

⁶³ NWDC, *LCS Concept of Operations*.

⁶⁴ Baskerville, Dräim, Sprigg. *The Littoral Combat Ship*. 39-40.

⁶⁵ NWDC, *LCS Concept of Operations*.

⁶⁶ US Fed News Service, "Navy, Army Name First Three Joint High Speed Vessels," *Washington DC US Fed News Service, Including US State News*, July 17, 2009, <http://www.proquest.com/>.

⁶⁷ Ann Roosevelt, "Joint High Speed Vessel On Track For Detailed Design Review," *Defense Daily* 241, no. 15 (January 2009): 2, <http://www.proquest.com/>.

⁶⁸ James Baskerville, Robert Draim, and Robert Sprigg, "The Littoral Combat Ship," *Marine Corps Gazette* 90, no. 3 (March 2006): 39-40, <http://www.proquest.com/>.

⁶⁹ Emelie Rutherford, "Marine Corps May Need Missile Mods for LCS," *Defense Daily* 244, no. 30 (November 2009): 2. <http://search.ebscohost.com/>.

⁷⁰ Emelie Rutherford, "Missile Mods for LCS".

⁷¹ Amy Wittman, "Good in the 'Green'," *Seapower*, October 2008, <http://www.proquest.com/>.

⁷² Emelie Rutherford.

⁷³ Christopher Cavas, "Defying Trend, DDG 1000."

⁷⁴ Headquarters U.S. Marine Corps, *A Concept for Distributed Operation*, (Washington, DC: Headquarters U.S. Marine Corps, April 25, 2005) I-II, <https://www.mccdc.usmc.mil/FeatureTopics/DO/A%20Concept%20for%20Distributed%20Operations%20-%20Final%20CMC%20signed%20co.pdf>

⁷⁵ Headquarters USMC, *A Concept for Distributed Operation*, VIII

⁷⁶ Headquarters USMC, *A Concept for Distributed Operation*, III

⁷⁷ Edward Tovar, presentation on "USMC Distributed Operations," Defense Advanced Research Projects Agency(DARPA), Presentation given during DARPAtech 2005 (August 9-11, 2005), 22, <http://www.darpa.mil/DARPAtech2005/presentations/ato/tovar.pdf> (accessed January 9, 2010).

⁷⁸ Geoff Fein, "Navy Secretary Hopeful LCS Will Be Cost Effective Approach To Reaching 313-Ship Fleet," *Defense Daily* 241, no. 12 (January 23, 2009): 3, <http://search.ebscohost.com/>.

⁷⁹ Donald Winter quoted in Geoff Fein, "Navy Secretary Hopeful".

⁸⁰ Emelie Rutherford, "Marine Corps: LCS Would Need Tweaks to Best Suit Marines, Special Ops" *Defense Daily* 243, no. 40 (August 26, 2009): <http://www.proquest.com/>.

⁸¹ Emelie Rutherford, "LCS Would Need Tweaks to Best Suit Marines".

APPENDIX A

Figure 1
Lockheed Martin LCS design concept

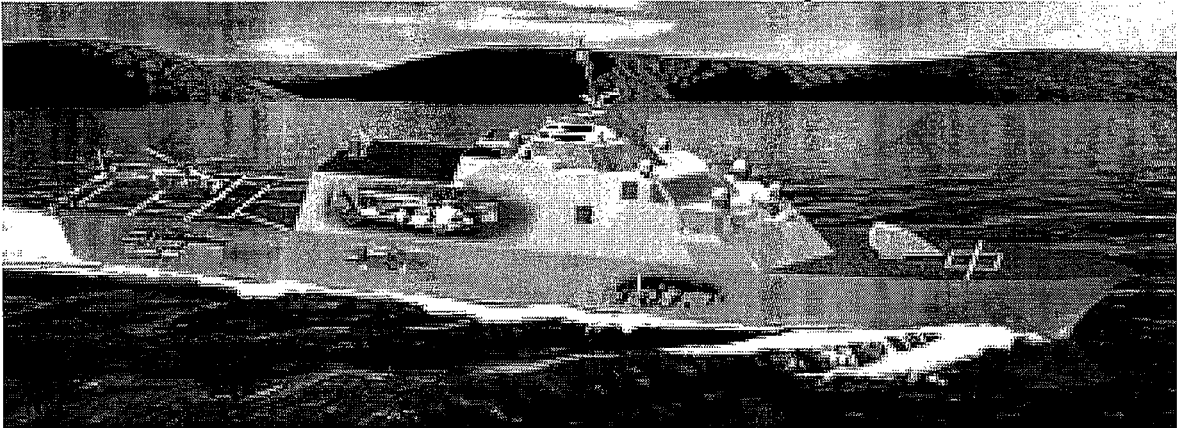
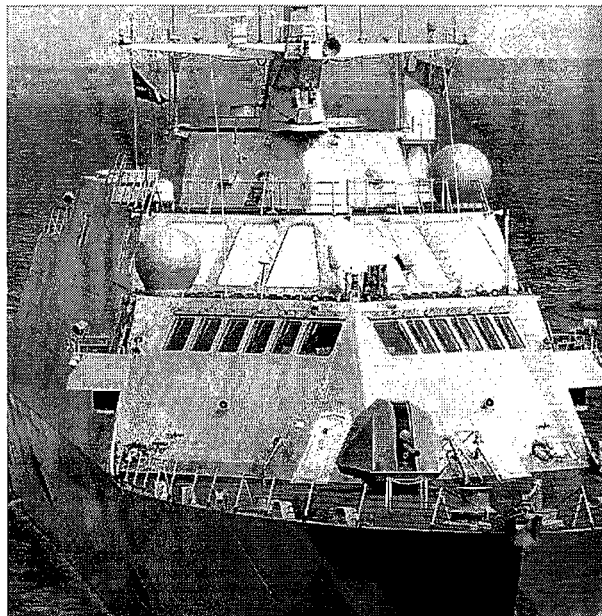


Figure 2
LCS 1 Freedom



APPENDIX A

APPENDIX A

Figure 3
Image of General Dynamics LCS design concept

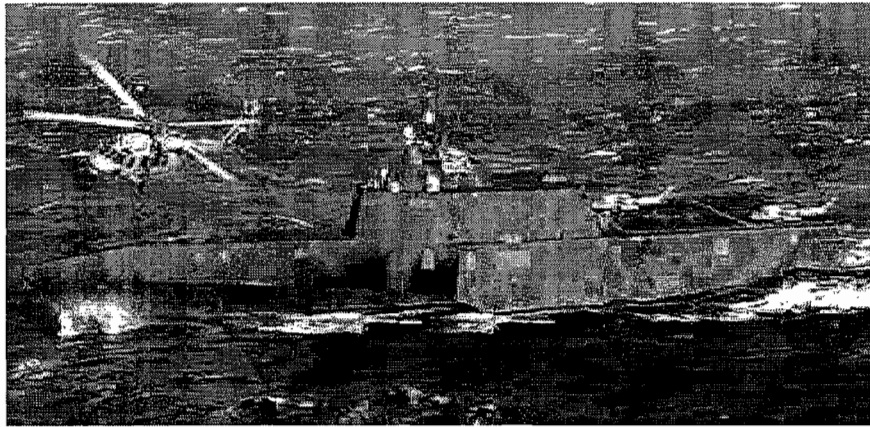
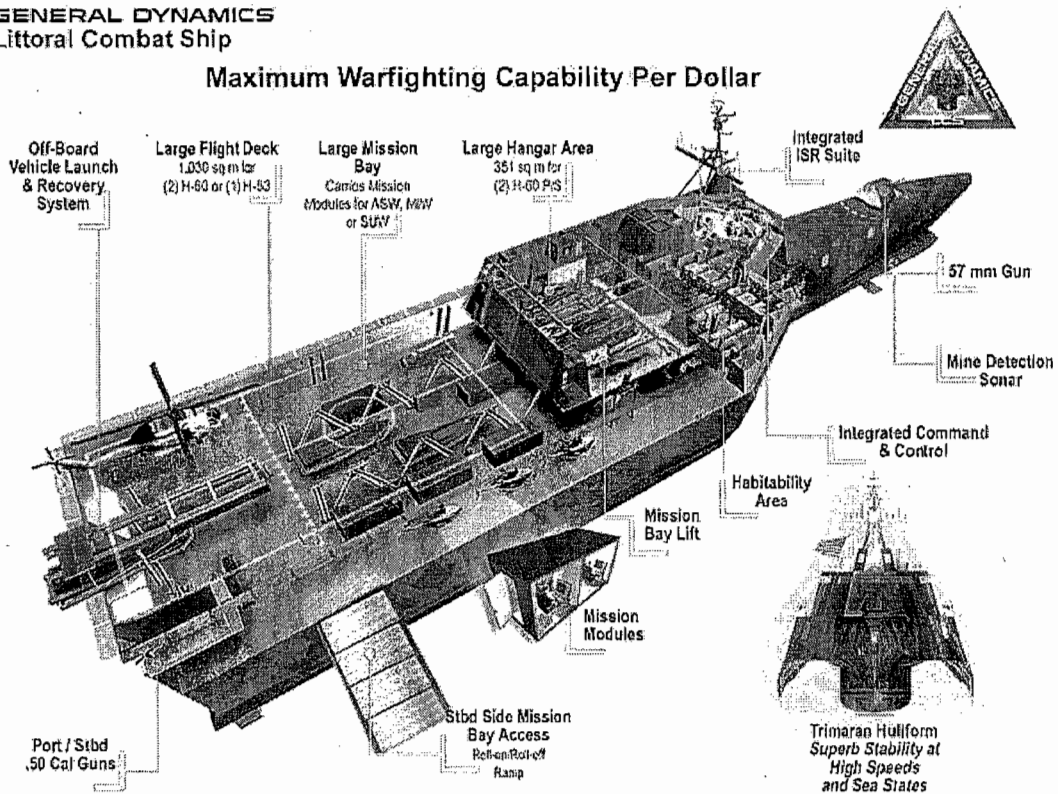


Figure 4
General Dynamics LCS interior design concept

GENERAL DYNAMICS
Littoral Combat Ship

Maximum Warfighting Capability Per Dollar



APPENDIX A

APPENDIX A

Figure 5
LCS 2 Independence built by General Dynamics

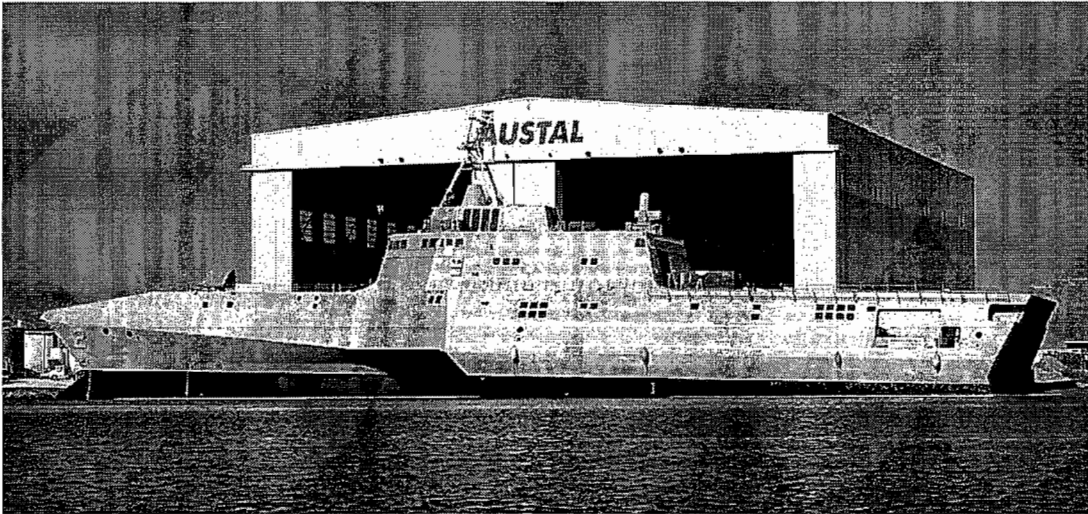
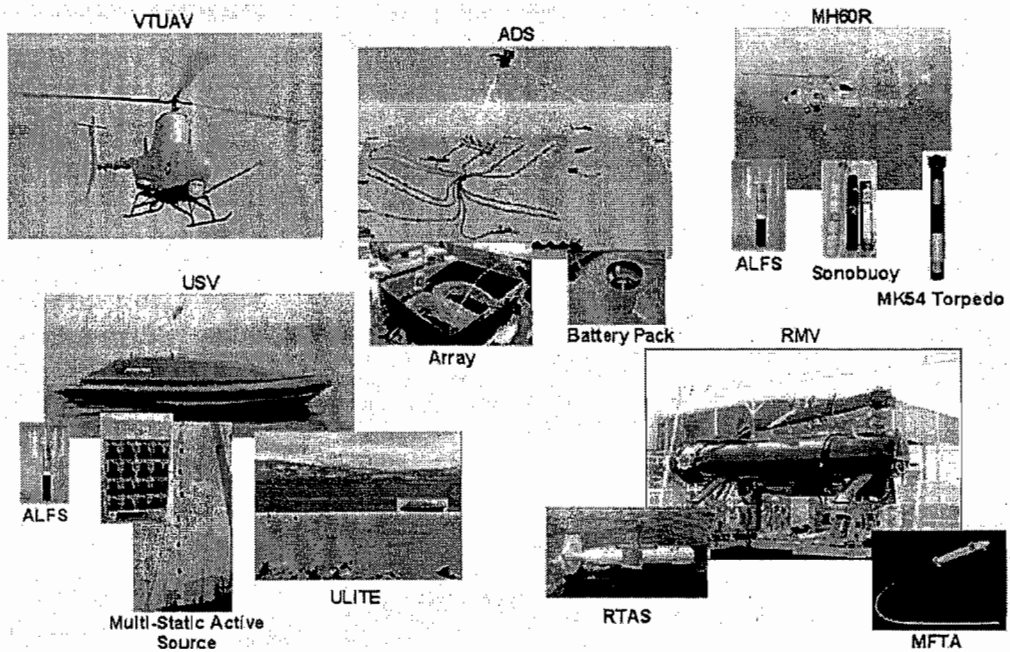


Figure 6
ASW Mission Package Components

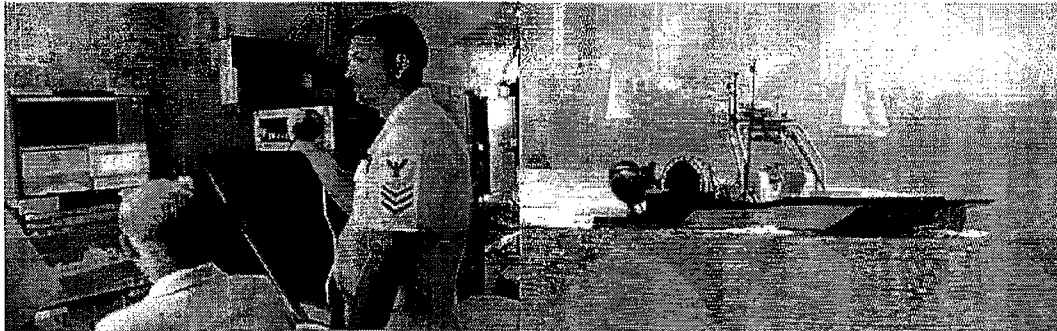


APPENDIX A

APPENDIX A

Figure 7
ASW Mission Package

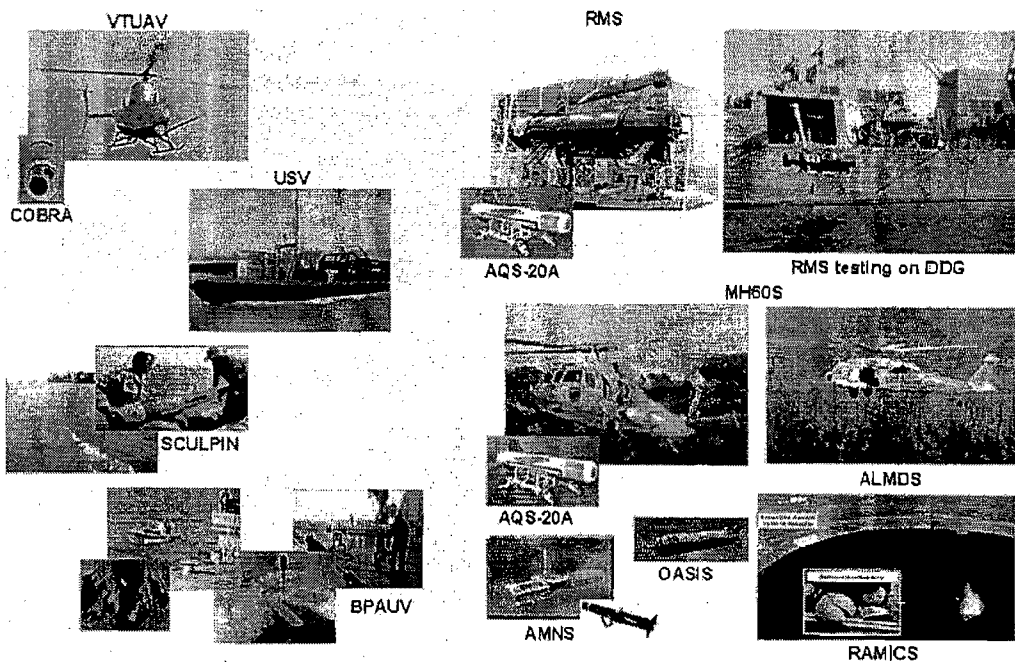
ASW Mission Package Rollout – September 2008



Sailors controlling the ASW USV from the Portable Mission Package Computing Environment (MPCE)

USV with Towed Array Sonar

Figure 8
MIW Mission Package Components

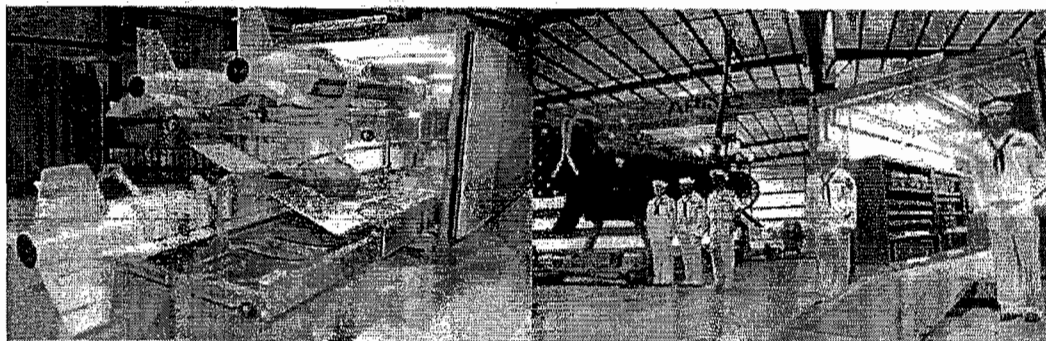


APPENDIX A

APPENDIX A

Figure 9
MIW Mission Package

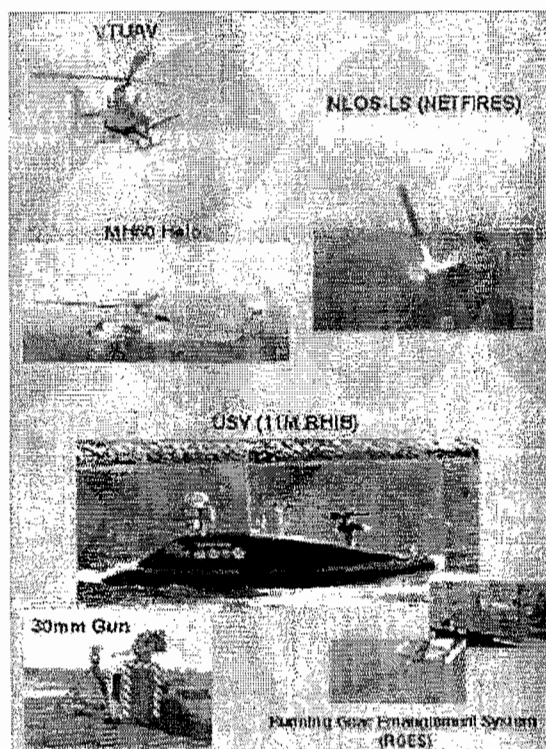
MIW Mission Package Rollout – September 2007



AN/AQS-20A Mission Module

RMS Mission Module

Figure 10
SUW Mission Package Components



APPENDIX A

Bibliography

- Abbott, Benjamin P. "Littoral Combat Ship (LCS) Mission Packages: Determining the Best Mix." Master's thesis, Naval Postgraduate School, 2008. <http://stinet.dtic.mil/>.
- Baskerville, James E, Robert P Draim, and Robert G Sprigg. "The Littoral Combat Ship." *Marine Corps Gazette* 90, no. 3 (March 2006): 39-40. <http://www.proquest.com/>.
- Burgess, Richard R. "Mission Takes Shape: Commissioning Awaits *Freedom, Independence* Readies for Sea Trials." *Seapower*, October 2008. <http://www.proquest.com/>.
- Carson, Daniel. "NSWC Littoral warfare Facility: Mission: Possible." *Washington McClatchy-Tribune Business News*, October 20, 2009. <http://www.proquest.com/>.
- Cavas, Christopher. "Defying Trend, DDG 1000 on Time, Budget." *Defense News*, August 17, 2009. <http://search.ebscohost.com/>.
- Cavas, Christopher. "New Littoral Ship Prices To Be Revealed." *Defense News*, October 7, 2009. <http://search.ebscohost.com/>.
- Cebrowski, A K, and Wayne P Hughes Jr. "Rebalancing the fleet." *U.S. Naval Institute Proceedings*, November 1999, 31-34. <http://www.proquest.com/>.
- Christiansen, Bryan J. "Littoral Combat Vessels: Analysis and Comparison of Designs." Master's thesis, Naval Postgraduate School, 2008. <http://stinet.dtic.mil/>.
- Clark, Vern. "Sea Power 21." *U.S. Naval Institute Proceedings*, October 2002, <http://www.navy.mil/navydata/cno/proceedings.html> (accessed February 4, 2010).
- Efimba, Motale E. "An Exploratory Analysis of Littoral Combat Ships' Ability to Protect Expeditionary Strike Groups." Master's thesis, Naval Postgraduate School, 2003. <http://stinet.dtic.mil/>.
- Fein, Geoff. "Littoral Combat Ship's Modularity - The shape of things to come for the Navy." *Defense Daily* 229, no. 36 (February 2006): 4. <http://search.ebscohost.com/>.
- Fein, Geoff. "Navy Secretary Hopeful LCS Will Be Cost Effective Approach To Reaching 313-Ship Fleet." *Defense Daily* 241, no. 12 (January 23, 2009): 3. <http://search.ebscohost.com/>.
- Fein, Geoff, and Terrance Etnyre. "Surface Warfare Enterprise Tackling LCS Manning, Training Challenges." *Defense Daily* 233, no. 11 (January 2007): 1. <http://www.proquest.com/>.

- Harts, Justin. "The LCS: Built to Fight." *U.S. Naval Institute Proceedings*, July 2006, 26-29. <http://www.proquest.com/>.
- Headquarters U.S. Marine Corps. *A Concept for Distributed Operations*. Washington, DC: Headquarters U.S. Marine Corps, April 25, 2005. <https://www.mccdc.usmc.mil/FeatureTopics/DO/>.
- Kimura, Eric. "A Gunboat Navy for the 21st Century." *U.S. Naval Institute Proceeding*, July 2005, 44-46. <http://www.proquest.com/>.
- Kreisher, Otto. "Checkered Past, Uncertain Future." *U.S. Naval Institute Proceeding*, January 2009. <http://search.ebscohost.com/>.
- Kreisher, Otto. "LCS Commitment." *Seapower*, March 2008. <http://search.ebscohost.com/>.
- Kreisher, Otto. "Littoral Combat Ship (LCS) Production Problems Threaten The U.S. Navy's LCS Programme." *Naval Forces* 30, no. 2 (2009): 26-31. <http://search.ebscohost.com/>.
- Long, Duncan, and Stuart Johnson, "The Littoral Combat Ship From Concept to Program," Case Studies in Defense Transformation. Number 7. Center for Technology and National Security Policy, 2007. <http://www.ndu.edu> (accessed January 9, 2010).
- Loren, Don. "Littoral combat ships will help U.S. Forces gain access." *National Defense* 87, no. 589 (December 2002): 20-21. <http://www.proquest.com/>.
- Lundquist, E. H. "One ship can't do it all." *NATO's Nations and Partners for Peace*, no. 3 (2004): 130-135. <http://www.proquest.com/>.
- Lundquist, E.H. "Protecting the Seabase." *Marine Corps Gazette* 89, no. 3 (March 2005): 31-32. <http://www.proquest.com/>.
- Milliken, Michael S. "The Impact Analysis of a Mixed Squadron, Containing LCS and Multi-Mission Surface Platforms, on Blue Force Casualties and Mission Effectiveness." Master's thesis, Naval Postgraduate School, 2008. <http://stinet.dtic.mil/>.
- Muradian, Vago. "Future Navy may Have Small, Tough Ships to Support Marines." *Defense Daily* 201, no. 36 (February 1999). 1. <http://www.proquest.com/>.
- Natter, Ralf and R. Robinson Harris. "The Navy's 'Tipping Point'." *U.S. Naval Institute Proceeding*, January 2009. <http://www.proquest.com/>.
- Navy Warfare Development Command, *Littoral Combat Ship Concept of Operations*, V3.1, February 2003. <http://www.globalsecurity.org/military/Library/report/2003/LCSCONOPS.htm#OperationalConcept> (accessed January 9, 2010).

- Ozdemir, Omur. "Evaluation And Comparison Of Freedom Class LCS and Other Frigates/Corvettes Against Small Boat, FPB and Submarine Threats in Confined Waters." Master's thesis, Naval Postgraduate School, 2009. <http://stinet.dtic.mil/>.
- Peterson, G. I. "A new breed of U.S. Navy Warship." *Naval Forces* 25, no. 4 (2004): 58-60, 62-65. <http://www.proquest.com/>.
- Roosevelt, Ann. "Joint High Speed Vessel On Track For Detailed Design Review." *Defense Daily* 241, no. 15 (January 2009): 2. <http://www.proquest.com/>.
- Russell, Jonathan C. "The Littoral Combat Ship: Is The US Navy Assuming Too Much Risk?" Master's thesis, U.S. Army Command and General Staff College, 2006. <http://stinet.dtic.mil/>.
- Rutherford, Emelie. "Marine Corps: LCS Would Need Tweaks to Best Suit Marines, Special Ops." *Defense Daily* 243, no. 40 (August 26, 2009): <http://www.proquest.com/>.
- Rutherford, Emelie. "Marine Corps May Need Missile Mods for LCS." *Defense Daily* 244, no. 30 (November 2009): 2. <http://search.ebscohost.com/>.
- Ryan, Paul. "LCS Will Transform Mine Warfare." *U.S. Naval Institute Proceeding*, December 2004, 37-39. <http://search.ebscohost.com/>.
- Scully, Megan. "Shoring Up Ship Building." *Government Executive* 41, no. 10 (August 2009): 42. <http://www.proquest.com/>.
- Standifer, Cid. "Freedom To Head South With First Surface Warfare Mission Package." *Insidedefense.com*, December 14, 2009. http://insidedefense.com/secure/display.asp?docnum=NAVY-22-49-13&f=defense_2002.ask (accessed January 9, 2010).
- Truver, Scott C. "Taking Back the Littoral: US Navy Littoral Combat Ship Programme Update...And More!" *Naval Forces* 27, no. 3 (2006): 68-82. <http://search.ebscohost.com/>.
- US Fed News Service. "Navy, Army Name First Three Joint High Speed Vessels." *Washington DC US Fed News Service, Including US State News*, July 17, 2009. <http://www.proquest.com/>.
- US Navy. *Littoral Combat Ships: Relating Performance to Mission Package Inventories, Homeports, and Installation Sites*, by Brien Alkire, John Birkler, Lisa Dolan, James Dryden, Bryce Mason, Gordon T. Lee, John F. Schank and Michael Hayes. Santa Monica, CA: RAND National Defense Research Institute, 2007.
- US News Service. "Navy Announces Contract Award Values For Littoral Combat Ships 3, 4." *Washington DC US News Service, Including US State News*, December 5, 2009. <http://search.ebscohost.com/>.

Walsh, Edward J. "Smart Shopping." *U.S. Naval Institute Proceeding*, June 2009, 88.
<http://www.proquest.com/>.

Williams-Robinson, Mckinnya J. "A Littoral Combat Ship Manpower Analysis
Using the Fleet Response Training Plan." Master's thesis, Naval Postgraduate School,
2007. <http://stinet.dtic.mil/>.

Wittman, Amy L. "Good in the 'Green'." *Seapower*, October 2008. <http://www.proquest.com/>.

Worthington, George R. "No Need for High Speed." *U.S. Naval Institute Proceeding*, November
2009. 82-84. <http://search.ebscohost.com/>.